

## **Knock Characteristics by Research Method**

### **1.0    Scope**

This method covers the knock characteristics of motor gasolines in terms of ASTM research octane number.

### **2.0    Summary**

The ASTM research octane number of fuel is determined by adjusting the compression ratio for the sample so that the knock intensity is equivalent to that of a standardization fuel of similar octane and then consulting a table to obtain the actual octane number based on the compression ratio.

### **3.0    Comments**

All samples shall be cooled to a temperature between 35°F and 50°F before the container is opened and the sample is introduced into the appropriate carburetor bowl.

### **4.0    Reagents**

- 4.1        ASTM isooctane.
- 4.2        ASTM 80 octane blend.
- 4.3        ASTM N-Heptane primary reference fuel.
- 4.4        ASTM Reference Fuel toluene.

### **5.0    Apparatus and Materials**

- 5.1        Bottles for reference fuel mixtures.
- 5.2        Research testing unit consisting of a single cylinder engine of continuously variable compression ratio, with suitable loading and accessory equipment and instruments.

6.0 Procedure

- 6.1 Fill the air humidity control tower with ice to a depth of at least 36 inches.
- 6.2 Set up the carburetor cooling system: attach the inlet hose to the pump and place the pump in a five gallon pail containing enough water to cover the pump. Plug in the pump and briefly pump water through the system and down the drain. Place the outlet hose into the pail and fill the pail with ice to enable ice water to circulate through the system.
- 6.3 Find an empty five gallon metal can in the flammable storage room and position it under the carburetor drain hoses. Place the hose ends in the opening in the can.
- 6.4 Bring the level of water in the engine heat exchanger reservoir so it is just visible in the bottom of the sight glass by adding distilled water through the top opening.
- 6.5 Turn on the cooling water to the heat exchanger.
- 6.6 Turn on the circuit breaker for the engine at the panel on the south wall of the engine room.
- 6.7 Before starting the engine:
  - 6.7.1 Check oil level - it should be above the mid-line mark on the sight glass at the front of the engine.
  - 6.7.2 Check to make sure the oil temperature is  $135 \pm 15^{\circ}$ .
  - 6.7.3 Check to make sure the fly wheel marks are set at top dead center.
  - 6.7.4 Uncover the opening on the top of the air humidity control tower.
  - 6.7.5 Fill the right carburetor bowl with warm-up fuel.
- 6.8 Start the engine with the four switches at the bottom center of the engine panel. To start, turn the start knob as far right as it goes and watch the oil pressure gauge. When the oil pressure reaches 30, release the start switch and turn on the ignition, air heater, and mixture heater switches.

- 6.9 Turn the carburetor feed knob to feed fuel to the engine from the carburetor bowl containing the warm up fuel.
- 6.10 Watch the oil pressure while the engine is running. If it drops to lower than 24 psi, turn the fuel selector to an off position and stop the engine. Correct the cause of the trouble before trying to restart the engine.
- 6.11 The heater switch on the engine panel should be in the inlet air heater position. The temperature should be adjusted to that specified for the prevailing barometric pressure. For example if the barometer reads 28.4, consult the chart at 28.4 to find 103° as the correct inlet air temperature.
- 6.12 Allow the engine to warm up until the inlet air temperature reaches the required setting and stabilizes. The engine coolant temperature should stabilize at  $212 \pm 3^{\circ}\text{F}$ .
- 6.13 While the engine is warming up, knock rating standards can be prepared as follows: (Make a quantity of each that will be adequate for the number of samples to be tested).
- |           |  |
|-----------|--|
| 90 octane | 50% of 100% isooctane<br>50% of 80 blend |
| 91 octane | 55% of 100% isooctane<br>45% of 80 blend |
| 92 octane | 60% of 100% isooctane<br>40% of 80 blend |
| 93 octane | 65% of 100% isooctane<br>35% of 80 blend |
| 94 octane | 70% of 100% isooctane<br>30% of 80 blend |
| 96 octane | 80% of 100% isooctane<br>20% of 80 blend |
| 98 octane | 90% of 100% isooctane<br>10% of 80 blend |
- 6.14 Before rating samples, the engine must be qualified on a toluene standardization fuel. Prepare this standardization fuel by pipetting 130 ml of ASTM N-Heptane primary reference fuel into a 500 ml volumetric flask and bringing to volume with ASTM reference fuel toluene. Mix well. This blend should rate at  $93.4 \pm .3$  research octane units.

- 6.15 Fill the left two carburetor bowls with 93 and 94 octane reference fuels. Place the toluene standardization fuel in the third carburetor bowl.
- 6.16 Read the barometer and consult the chart for the digital counter correction. Add the counter correction to the value of the bottom number on the digital counter and set the top number on the digital counter to this sum.
- 6.17 Turn the selector valve to operate on the 93 octane reference fuel and set the digital counter bottom number to 770. Adjust the fuel/air ratio to give the maximum reading on the knockmeter. The fuel/air ratio must be between 0.7 and 1.7.
- 6.18 When the knockmeter reaches equilibrium, use the meter adjust knob to bring the reading to  $50 \pm 2$ . Record the reading.
- 6.19 Turn the selector valve to operate on the toluene standardization fuel and adjust the fuel/air rates to give the maximum reading on the knockmeter.
- 6.20 When the meter has reached equilibrium, adjust the cylinder height to bring the meter reading to the same point that was set for the 93 octane reference fuel. Record the bottom number on the digital counter and consult the chart for the corresponding octane.
- 6.21 Repeat steps 15.5.6.17-15.5.6.20 at least twice more. The average of the octane ratings for the toluene standardization fuel should be  $93.4 \pm .3$ .
- 6.22 If the result is not within limits, the problem must be found and corrected before testing samples. Repeat steps 15.5.6.17-15.5.6.20. The engine must rate before samples can be run.
- 6.23 Use the following guidelines for rating samples:
- |                      |         |
|----------------------|---------|
| Regular and unleaded | 91 - 92 |
| Silver               | 93      |
| Alcohol blends       | 94      |
| Premium              | 96 - 98 |
- 6.24 Fill the right two carburetor bowls 1/4 to 1/2 full with the first two samples to be tested. Manipulate the drain valves to remove all bubbles from the tubing to the carburetor.

- 6.25 Turn the selector to operate on the proper octane reference fuel and set the digital counter bottom number to correspond to the counter setting from the chart. The fuel level must be between 0.7 and 1.7.
- 6.26 Repeat steps 15.5.6.17 and 15.5.6.18.
- 6.27 Turn the selector valve to operate on the first sample and adjust the fuel/air ratio to give the maximum reading on the knockmeter.
- 6.28 When the meter has reached equilibrium, adjust the cylinder height to bring the meter reading to the same point that was set for the octane reference fuel. Record the bottom number on the digital counter and consult the chart for the corresponding octane.
- 6.29 Continue rating samples as above, checking the octane reference fuel after every five samples are tested or more frequently if necessary.
- 6.30 After all the samples have been tested, turn the fuel selector valve to an intermediate position to shut off the fuel supply to the engine. When the knockmeter needle starts dropping, allow it to drop about 20 units and then turn off the mixture heater switch, air heater switch and ignition switch in that order. Then turn off the start switch and hold in the stop position until the engine comes to a complete stop.
- 6.31 Turn off the detonation meter switches.
- 6.32 Rotate the flywheel to top dead center on the compression stroke to protect the valves and cylinder parts from corrosion.
- 6.33 Drain all carburetor bowls and remove the waste collection can.
- 6.34 Disconnect the carburetor cooling system and drain the lines.
- 6.35 Turn off the cooling water to the engine.
- 6.36 Turn off the engine circuit breaker in the knock room.